Water Audit

Grade Level:
Middle School

Subject Areas:
Math, Health, Environmental Science

Duration:
Preparation time: 10 minutes

Activity time: two 50 minute periods

Setting:
Classroom and Home

Skills:
Gather, Organize, Analyze, Interpret, Evaluate

Vocabulary:
audit, desalinization, water diversion, retrofitting, potable

Summary

Students conduct a home water audit and compare and contrast results with and without the implementation of water conservation practices.

Objectives

Students will:

- provide a rationale for implementing home water conservation measures.
- describe the benefits of at least five home water conservation practices.
- recommend water conservation strategies to be implemented within their own homes.

Materials

- *Conserve Water!* Student Copy Page
- *Water Audit Data Sheet I* Student Copy Page (one copy per student)
- *Water Audit Data Sheet II* Student Copy Page (one copy per student)

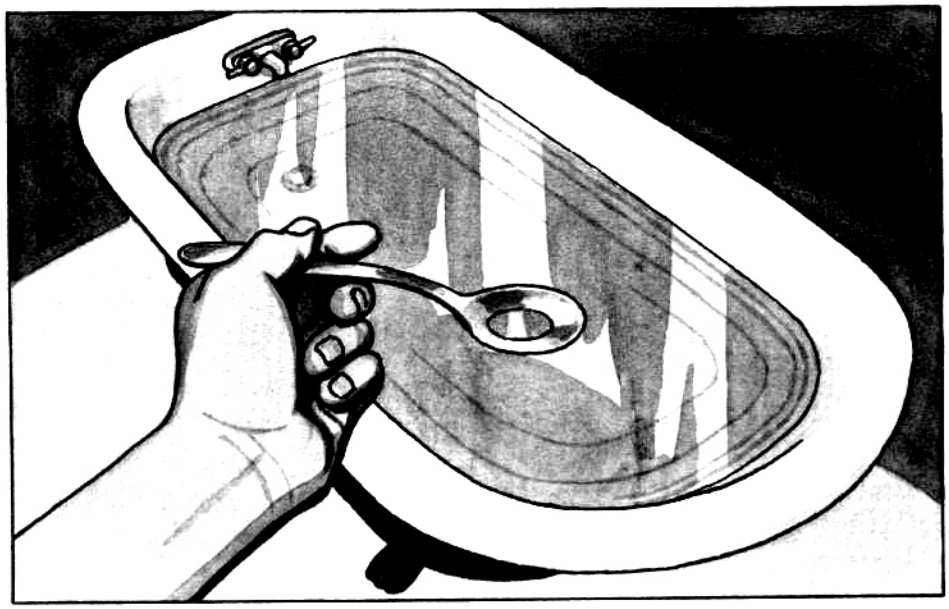
Background

Earth is often referred to as the blue planet or the water planet. Photographs of Earth taken from space are predominantly colored in shades of blue. This is not surprising since water circulating in oceans or frozen in ice fields covers about 71 percent of the planet. In fact, scientists estimate that there is enough water on Earth to cover the whole United States with water 93 miles deep! Nature uses and moves more water through the water cycle than any other thing. For example, each day the sun evaporates 1,000,000,000,000 (a trillion) tons of water.

Switching from the global to the personal perspective, the human body has nearly the same percentage of water as the planet—about 65—70 percent. The brain is almost all water (95 percent) and sayings that allude to "dry bones" are misleading—the human skeleton is 25 percent water.

So, if we are such watery creatures living in a watery world, why do we need to use water wisely? It boils down to a simple formula: the right amount of water, in the right place, of the right quality, at the best price. Water that is good enough to drink, that can be used by agriculture or industry and shared with wildlife, is a precious resource.

All of the water on the planet is not available for use by plants or animals. About 97 percent of the water on Earth is found in oceans. Only about 3 percent is fresh. Of this fresh water, a large percentage is frozen in icecaps and glaciers or is unavailable because it is too far underground, polluted, or trapped in soil. Stated simply, if a full bathtub holding 30



gallons represented all the water in the world, about one-half teaspoon of water would symbolize the amount of potable, available fresh water.

On a global scale, only a small percentage of water is available, but this percentage represents a large amount per individual. The irony is that for some people water may appear plentiful while for others it is a scarce commodity. Water is not equally distributed on the planet, and its availability depends on geography, climate, and weather.

For example, in the western United States, the climate is predominantly dry. In many areas, people rely on systems of dams and diversions to deliver fresh water, often from distant places. The water that runs from a tap in Los Angeles, California has likely traveled hundreds of miles from the Rocky Mountains down the Colorado River and across the Mojave Desert. This delivery system is not only extensive, it is expensive!

Even if you live in a water-rich area, water treatment costs money. Water flows from its source—such as a river or well—through pipes to water treatment plants where it is cleaned. From the water treatment plant, it moves through pipes to our residences and industries. After use, water must be treated before it is released into a river or other water source.

Communities can suffer water shortages because of drought or sudden increases in population growth. Building larger water treatment plants (or in some areas, dams), desalinization facilities, or water diversion projects can increase a community's water supplies. However, these options are expensive and some communities cannot afford them. What can citizens do?

Wherever a community is located, citizens can use less water by implementing water conservation practices. However, before a water conservation program is put into practice, a water audit can provide excellent baseline data from which to measure the progress of the program.

An audit is one of the first steps to take along the path to water conservation knowledge and action. Just as a financial audit informs a person about the way he or she truly makes and spends money, a water audit quantifies the actual use of water in an informative way. Before we can take steps to solve problems, we need documented benchmarks to start from, and to measure our progress against.

Water audits are becoming a standard feature of long-range planning for industries, communities, and individuals. The findings are, without exception, illuminating; and they are often surprising. As the costs of providing water escalate, the importance of benchmark data and conservation strategies based on reliable figures also rises. Several of the case studies (the bathroom retrofitting program in New York City,

the measures taken by the water authority in Boston, and others) depended on water audits as a critical part of the decision-making process.

Procedure

Warm Up

The *Conserve Water!* assessment is designed to determine if students understand the availability of fresh, potable water; the distribution of water on the planet; the cost of water (water and wastewater treatment); and the potential of water conservation measures to offset a community's increased water demands.

Distribute the assessment and allow students a few minutes to complete the form. Then, go through each question with students, discussing their responses and introducing information and concepts important for understanding the rationale for conducting a home or school water audit.

The Activity

1. Organize students into cooperative learning groups.
2. Have each group list all the ways they use water in a 24-hour period inside and outside their homes.
3. Record their ideas on the board.
4. Hand out the *Water Audit Data Sheet I* Student Copy Page to each student.
5. Ask students to review the sheet.
6. Ask them to record on the sheet in column A by each water use the number of times they believe they conduct that activity in a 24- hour period.
7. Instruct them to record the number of times they actually conduct each water use activity over the next 24 hours in column B of *Water Audit Data Sheet I.*
8. Have students compare the number of gallons they predicted with their actual use. Did they use more water than they guessed? Less? Were students surprised by the amount of water they used?
9. Ask students if they know of any ways to reduce the number of gallons of water they use. Do their parents frequently ask them to turn off the shower? Why? Is water free, just because it flows freely from the faucet?
10. Do students believe that using water resources wisely makes sense?
11. Ask students to suggest some water conservation practices.
12. Hand out *Water Audit Data Sheet II* Student Copy Page. Ask students to again record the amount of water they use in a 24-hour period, but this time they will implement as many water conservation practices as they can.
13. Ask students to calculate the total amount of water they used in a 24-hour period when they were practicing water conservation measures. Direct students to compare the total number of gallons on *Data Sheet I* to the total on *Data Sheet II.*

Wrap Up

Have students respond to the following questions related to water conservation practices:

- How did their water consumption change after implementing water conservation measures? How many gallons of water did they save? Were they more careful about their use of water after they realized how much they used?
- Which conservation measures were the easiest to institute?
- Which practices were the most difficult? Why?
- If you were only allowed 30 gallons of water per day, to what water uses would you give the highest priority?
- Select three of the water conservation practices that you found fairly easy to use. If you were to apply these three practices routinely, how many gallons of water would you save each month? If every member of your family consistently employed these practices, how many gallons would be saved per month within your own household?
- Is it a good idea for a school, business, or hospital to conduct a water audit? Why would a water audit be beneficial for these institutions?

Have students write a set of at least five recommendations or suggestions for their family based on their home water

audit. These suggestions should include short- and long-term actions. For example, for long-term actions, students may suggest that low-flow showerheads be installed or water-saving appliances purchased when the current ones no longer function. Have students share their recommendations with the class.

Assessment

Have students:

- indicate their responses on the *Conserve Water!* assessment form (*Warm Up*).
- complete *Water Audit Data Sheet I* in order to calculate how much water they use in a 24-hour period (steps 6, 7, and 8).
- complete *Water Audit Data Sheet II* in order to compute how much water they use in a 24-hour period when they are implementing water conservation practices (steps 12 and 13).
- formulate a list of at least five recommendations for their family based on their home water audit (*Wrap Up*).

Extension

Although it is certainly more complicated, students may conduct a water audit of their school. Engage in this activity only after securing full permission from school administrators. The forms for a school water audit are included with this activity.

Break the class into three audit teams, as follows:

- Research and information team
- Indoor water use team
- Outdoor water use team

Hand out copies of the *Team Worksheets* Student Copy Pages and explain each team's job description (also explained on the worksheets) as follows:

- Research and information: To track down billing records; identify historic and yearly water use patterns; and conduct interviews with appropriate officials to pinpoint water use hot spots.
- Indoor water use: To document major indoor uses of water, pinpoint problem areas (leaks), and gather as much specific information as possible.
- Outdoor water use: To document outdoor uses of water, pinpoint problem areas, and gather as much specific information as possible.

Set a deadline for when teams should have results (one week should be sufficient) and tell them when they will report their findings to the class.

Allow the class time to organize their approach to the tasks.

Be available to provide suggestions, assistance, or information during the audit process.

After the allotted audit time, regroup and ask one person from each team to present their findings to the class. Ask them to summarize their data, highlight the most obvious areas of concern, and list their conclusions pertaining to the school's use of water.

Once all the teams have reported, reconfigure the groups. Each of the new teams should have representatives from all three original teams.

Tell students that the point of all their initial work was to provide foundation information on which future policy and action can be based. The second phase of their work together is to formulate a set of strategic suggestions to present to school officials; their job is to aid in developing a comprehensive, schoolwide water conservation program.

Give the new teams a class period (30–50 minutes) to work through the *Strategy Sheet* Student Copy Page, pooling their collective information.

When the groups finish, ask for a spokesperson from each to present the basic elements of their strategic suggestions.

Tell students that they've now gone through the essential steps of a basic audit, and they've come to some conclu-

sions as a result. The next phase is to organize their data and suggestions in a concise, factual, and persuasive statement.

As a class, fill out a single, final *Strategy Sheet*, combining the best and most practical information from their audit process, along with a summary of the best strategy suggestions.

If it can be arranged, invite school officials to hear the class's final report and summary in a formal presentation. Alternatively, the class could send a delegation to meet with school officials and make a presentation.

Resources

The Watercourse. 1999. *Conserve Water* Student Booklet. Bozeman, Mont.: The Watercourse.

The Watercourse. 1999. *Project WET Curriculum and Activity Guide*. Bozeman, Mont.: The Watercourse.

Angelo, Thomas A., and K. Patricia Cross. 1993. *Classroom Assessment Techniques*. San Francisco: Jossey-Bass Publishers.

Johnson, Cynthia. *Water Ways*. 1997. Florida: Office of Public Instruction, St. Johns River Water Management District.

Conserve Water!

This is not a test, so it is okay to answer "I don't know." After you complete these questions, you and other students will have a discussion with your teacher guided by your responses. This is a tool to help you learn more about water conservation.

1. Where does the water come from that flows out of your faucet at home?
   a. Home well
   b. Flows through pipes from the city water treatment facility
   c. Directly from the river or ocean
   d. I don't know

2. Is water that flows out of your faucet at home free of charge?
   a. Yes
   b. No
   c. I don't know

3. Where does water go after it is flushed down the toilet or swirls down the drain in your home?
   a. To the city wastewater treatment plant
   b. Directly to the river
   c. Through the home septic system
   d. I don't know

4. If a bathtub full of water represents all the water in the world, what measurement below shows the amount of water in the world that is fresh, usable water?
   a. One cup of water
   b. One bathtub full of water
   c. One teaspoon of water
   d. One bucket of water

5. What percentage of the human body do you believe is made up of water?
   a. 50%
   b. 10%
   c. 70%
   d. 5%

6. Why are some places in the world dry and others very wet? That is, why is water distributed unevenly throughout the world?
   a. Some places just waste a lot of water so it is dry
   b. Because of differences in weather, climate, and geography
   c. In some places, the sun never sets, so it is always hot and dry
   d. I don't know

7. Do you believe it is possible for individuals to change their habits and use less water? Do you think that individuals choosing to use less water can have a positive impact on the water supplies of their community? (Write 2 to 3 sentences to answer this question.)

Water Audit Data Sheet I
Home Water Audit

Water use	Column A Predicted # of water uses per day	Column B Actual # of water uses per day	Column C # of gal. per use	Column D Actual # of gal. used per day (B x C = D)
Brush teeth for two minutes, water running			6 gallons	
One toilet flush			5 to 7 gallons	
Wash dishes by hand, rinse in running water			20 gallons	
Shower			5 gallons/minute	
One dishwasher cycle			12 to 15 gallons	
Bath			30 gallons	
Wash hands, water running			3 gallons	
One clothes-washing cycle			50 gallons	
Get a drink with water running			1/4 gallon	
Water lawn, 10 minutes			75 gallons	
Wash car with hose running			10 gallons/minute	
				TOTAL:

1. Write down any other water uses that are not listed. Research to find out how many gallons of water that use requires.
2. Think of how often you directly use water every day. Write down how many times you think you conduct a particular activity each day in column A.
3. Throughout the following day (as soon as you get up in the morning) record how many times you actually use water.
4. Multiply the number of times you use water by how many gallons each use generally requires.
5. Add all the numbers in column D.
6. Write your answer in the last box in Column D. This is the estimated number of gallons of water you use every day.

Water Audit Data Sheet II

Home Water Audit

Water use	Column A Water Conservation Action (suggested or your own action)	Column B # of water uses per day	Column C Estimated # of gal. per use		Column D Actual # of gal. used per day B x C = D
			without conservation action	with conservation action	
Brushing teeth for two minutes, water running	Brush and rinse, water not running		6 gal.	$^1/_2$ gal.	
One toilet flush	Low-flush toilet		5-7 gal.	3 gal.	
Wash dishes by hand, rinse in running water	Wash dishes and dip in pan of water to rinse		20 gal.	5 gal.	
Shower, water running	5 minutes with low-flow showerhead		*5 gal./min.	12 gal.	
One dishwasher cycle			12-15 gal.		
Bath			30 gal.		
Wash hands with water running	Turning off water between wash and rinse		3 gal.	$^1/_2$ gal.	
One clothes-washing cycle	Adjusted water level		50 gal.	25 gal.	
Get a drink with water running	Pour glass from water pitcher in 'fridge		$^1/_4$ gal.	$^1/_{16}$ gal.	
Water lawn, 10 minutes			75 gal.		
Wash car with hose running	Use bucket, sponge, and controlled-flow nozzle		**10 gal./min.	5 gal. total	
					TOTAL:

*5 gal. x length of shower in minutes = total water use

**10 gal. x number of minutes hose is running = total

1. Write down any water uses that are not listed.
2. Conduct your daily water activities, but think of ways in which you could conserve water. Several suggestions are listed in the chart, but you may contribute any ideas you have and estimate your water savings.
3. Add up the total number of gallons in Column D.
4. Compare the total number of gallons in Column D with the number of gallons you used on *Water Audit Data Sheet I.*
5. How many gallons did you save in one day by practicing a few simple water conservation actions?
6. How many gallons would your family save in one day if everyone participated in these water conservation actions?
7. How many gallons would your family save in one month?

Team Worksheet—Research and Information

Your role in the audit is to conduct research and interviews to document your school's water use figures and establish general water use patterns.

1. Identify the offices and individuals responsible for handling water at your school (fiscal manager, accountant, maintenance department, building manager). Contact these offices for an interview appointment with the people who have direct knowledge about or information on the school's water use.

2. See if you can obtain copies of water bills and meter readings over the past year (longer if possible). Analyze them for times of peak and low use and any other obvious patterns.

3. Through meter readings and interviews, try to identify the major water users at the school (pool, sprinkler system, gym showers, bathrooms) and the times of peak demand.

4. Find out if school officials have a way of itemizing water use for different parts of the school (separate meters are the most reliable way to do this).

5. Either from actual figures or interview information list your school's top five uses of water.

_____

_____

_____

_____

_____

6. In your interview (especially when you talk with people involved in the day-to-day use of water—pool maintenance, lawn watering, etc.) ask specific questions like:

- What are the top water consumption activities at the school? On what information do you base that conclusion?
- In what areas is water used most inefficiently?
- Have you noticed specific water fixtures that leak persistently?
- In your opinion, what measures could be taken to conserve water most effectively at school?
- How could you more precisely document the school's water use?

7. Compare information from the various interviews to find common ground, and summarize your findings on a separate piece of paper.

Team Worksheet—Indoor Water Use

Your role is to survey the school building and document the major users of water. You will also search out leaks and other obvious problem areas.

1. Begin by touring the school buildings to take an inventory of water consuming fixtures/installations. As much as possible, document how much water each fixture uses. Cover at least the following:

Fixture/Installation Total #	Water Consumed/Used	
Indoor swimming pool		
Toilets/urinals		
Showers		
Drinking fountains		
Hot water heating pipes/AC		
Boiler		
Utility closets		
Bathroom sinks		
Indoor sprinkler system		

2. If you come across any leaky fixtures as you conduct the survey, do your best to measure the wasted water. Put a cup or jug under the leak and time it for one minute. Measure the amount of water, then multiply by 60 to get the amount lost every hour; multiply again by 24 to arrive at the daily total.

3. Identify fixtures that could be replaced with more efficient models (aerated faucets, low-flow showerheads, low-flow toilets) and multiply by the total number of fixtures.

4. Calculate several examples of the yearly savings that would result from some basic renovations. For example, how much water would be saved every year if the school fixed the leaks you found? If the school installed more efficient showerheads or low-flow toilets, how many gallons would be saved every 100 flushes or every 100 showers?

5. Are there too many water fixtures in some areas (drinking fountains, bathrooms)? Could the school reasonably do without some of these? Are the fixtures located in the best spots?

6. In general, what are the most intensive indoor uses of water at your school?

7. Are there other comments you would add after your tour? Other areas of concern you think would be worth investigating?

Team Worksheet—Outdoor Water Use

Your role is to survey the school grounds and document the major uses of water. You will also search out leaks and other obvious problem areas. (During winter months in some climates students will have a hard time documenting some aspects of outdoor water use. They can still take their tour and make observations, but they will probably want to supplement their research with interviews with groundskeepers, maintenance staff, and so on.)

1. Start with a tour of the school grounds. Inventory all the obvious water-consuming devices. If possible, document how much water is used in each application. Likely outdoor water fixtures include:
   - sprinkler systems
   - outdoor pool
   - fountains or ponds
   - outside faucets

2. If possible, measure any leaks you find along the way by collecting water for one minute, multiplying by 60, and then again by 24 to arrive at the water lost every day.

3. Identify fixtures that could be made more efficient (drip irrigation, timers on sprinklers, covers for outdoor pools to reduce evaporation) and try to estimate the savings that might be achieved.

4. Consider other avenues of outdoor water conservation. For example, designing a water conservative landscape; a watering regime tied to times of day and climate conditions that would minimize evaporative loss; adjusting sprinkler heads so that water is not wasted by watering asphalt; the possibility of recirculating/reusing water for some applications. Write up a summary of your suggestions.

5. After your tour, list the top outdoor uses of water at the school and brainstorm suggestions to make conservation improvements in those areas.

6. Did you come up with other observations or insights you'd like to comment on? If so, address these on a separate sheet of paper.

Strategy Sheet

Now that you've gathered a quantity of raw data, you can draw some conclusions and make informed suggestions to your school. Pool the information collected by the three teams and use this form to summarize and direct your findings.

1. List the major uses of water at your school (the most dramatic and easily achieved results usually come from targeting the biggest water users).

Top Indoor Consumers	Top Outdoor Consumers

2. Briefly describe the leaks found by teams and list the three that are most serious.

_____

_____

_____

3. How much water could your school save every year if they fixed every leak found by your group?

4. Based on your study of water bills, how much money would the school save by fixing all the leaks?

Strategy Sheet, continued

5. What measures can you suggest that will have the most dramatic impact on water savings for your school?

Indoor:

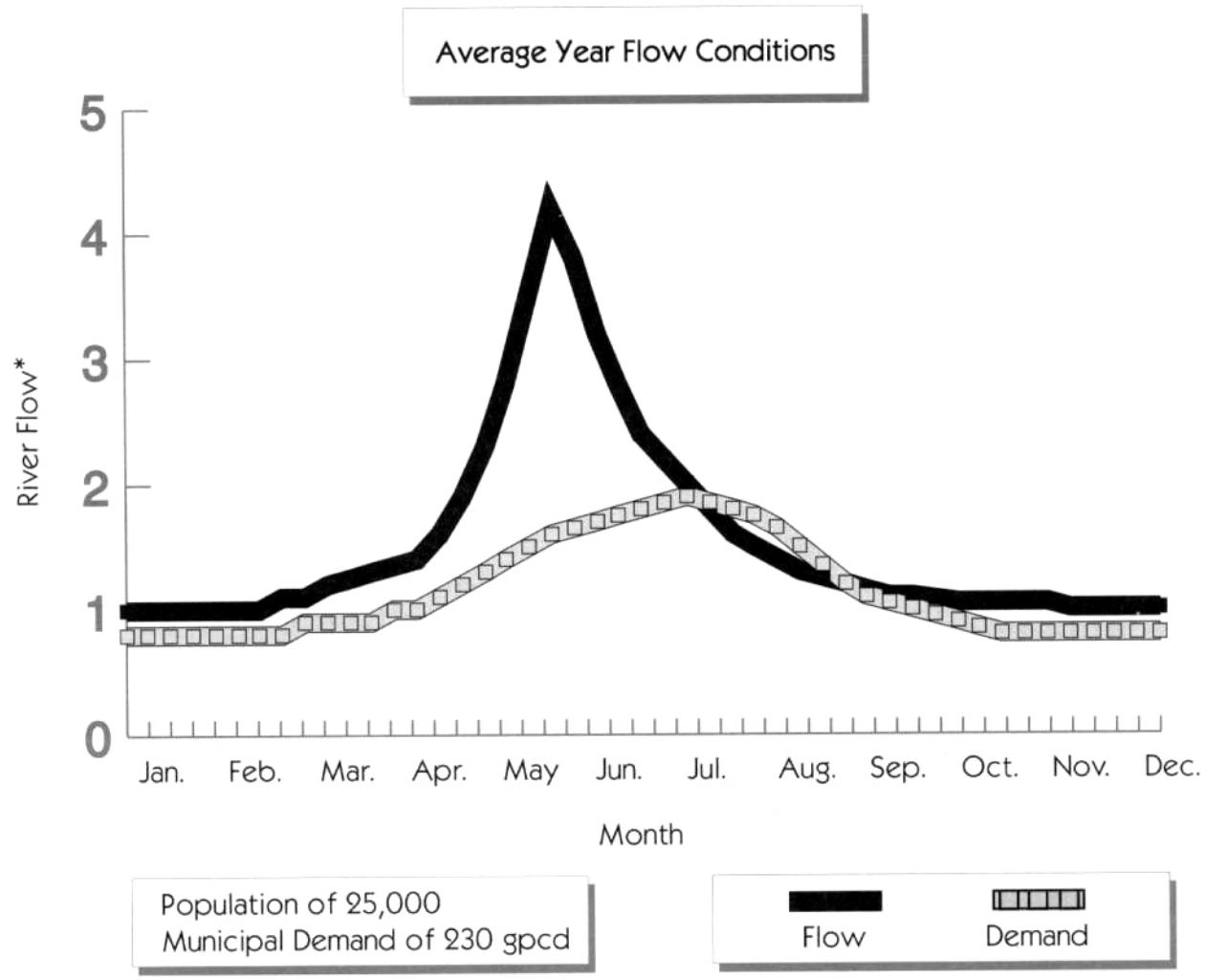
Outdoor:

6. Come up with three to five concrete examples of water savings your school could achieve through simple measures or changes in practice (e.g., the installation of low-flow toilets or toilet dams would save the school 3 gallons/flush). If possible, give one or two examples of the potential financial savings that would accrue through lower water bills as a result of conservation. (For instance, if low-flow toilets saved 50,000 gallons/month, the school would pay X dollars less on the monthly water bill.)

a. Water conservation measures

b. Financial savings that would result

Hydrograph for the Year 2000



*Number 1 represents the base flow of the river and ascending numbers are proportional to the base flow.

This activity was used with permission from Project WET. Project WET guides are available through teacher in-service workshops offered statewide. For more information about workshops, please visit www.deq.state.va.us/education/wetinfo.html. You can order a copy of the Water Conservation guide from which these activities are reprinted by visiting www.montana.edu/wwwwater/publications/module.html#educators%20%20